Space Weather Technical Forecast

Issued on Thursday, 28 March 2024 at 13:03 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further Minor/Moderate radio blackouts (R1/R2) expected. Electron Fluence likely rising above the Active threshold during the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with the largest flare an M7.0 peaking at 28/0629 UTC from AR3615. There are currently five sunspot regions on the visible disc. AR3615 is by far the largest and most magnetically complex group, with at least one delta spot and continued reconfiguration of spots, but it is becoming more difficult to assess as it approaches the limb. All remaining spots are comparatively small and simple, with little change.

No significant Earth-directed Coronal Mass Ejections (CMEs) were observed in available coronagraph imagery over the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind at L1 measured by ACE and DSCOVR started at elevated levels (around 530km/s) in the aftermath of the CME that arrived on the 24th March, with a steady decline to slightly elevated levels around 430km/s at time of writing. The solar wind density started at just above average levels, declining to average, but there appear to have been some significant data dropouts over the past 24 hours. The IMF was at weak levels, below 6nT. Bz fluctuated weakly between +2nT to -2nT. The phi angle has been generally positive (away from the sun).

The net result of the above solar wind measures was Quiet to Unsettled (Kp1-3) geomagnetic conditions.

Energetic Particles / Solar Radiation: Solar radiation was below the S1 threshold, but still a little above background levels with a slow declining trend evident. High energy electron flux (greater than 2MeV) observed at GOES16 was at normal background to moderate levels. The observed 24-hour fluence was below the Active threshold, with a value at 28/0000UTC of 3.58e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is expected to continue, with further M-class flares expected primarily from AR3615 through the forecast period, with a chance of an isolated X-class flare.

Solar Wind / Geomagnetic Activity: A CME associated with the X1.1 flare from a broad region north of AR3614 on the 23rd March, produced a complex halo CME which arrived at L1 at 24/1410UTC. There are no newer significant Earth-directed CMEs currently in the forecast.

Solar winds will decline towards background levels as the impacts from the CME continue to wane, along with any residual enhancement associated with CH12/- also clearing. Connection with a HSS from CH15/+ is possible towards the end of the period, but little enhancement of solar wind or geomagnetic activity is expected.

Geomagnetic activity is expected to be Quiet to Unsettled.

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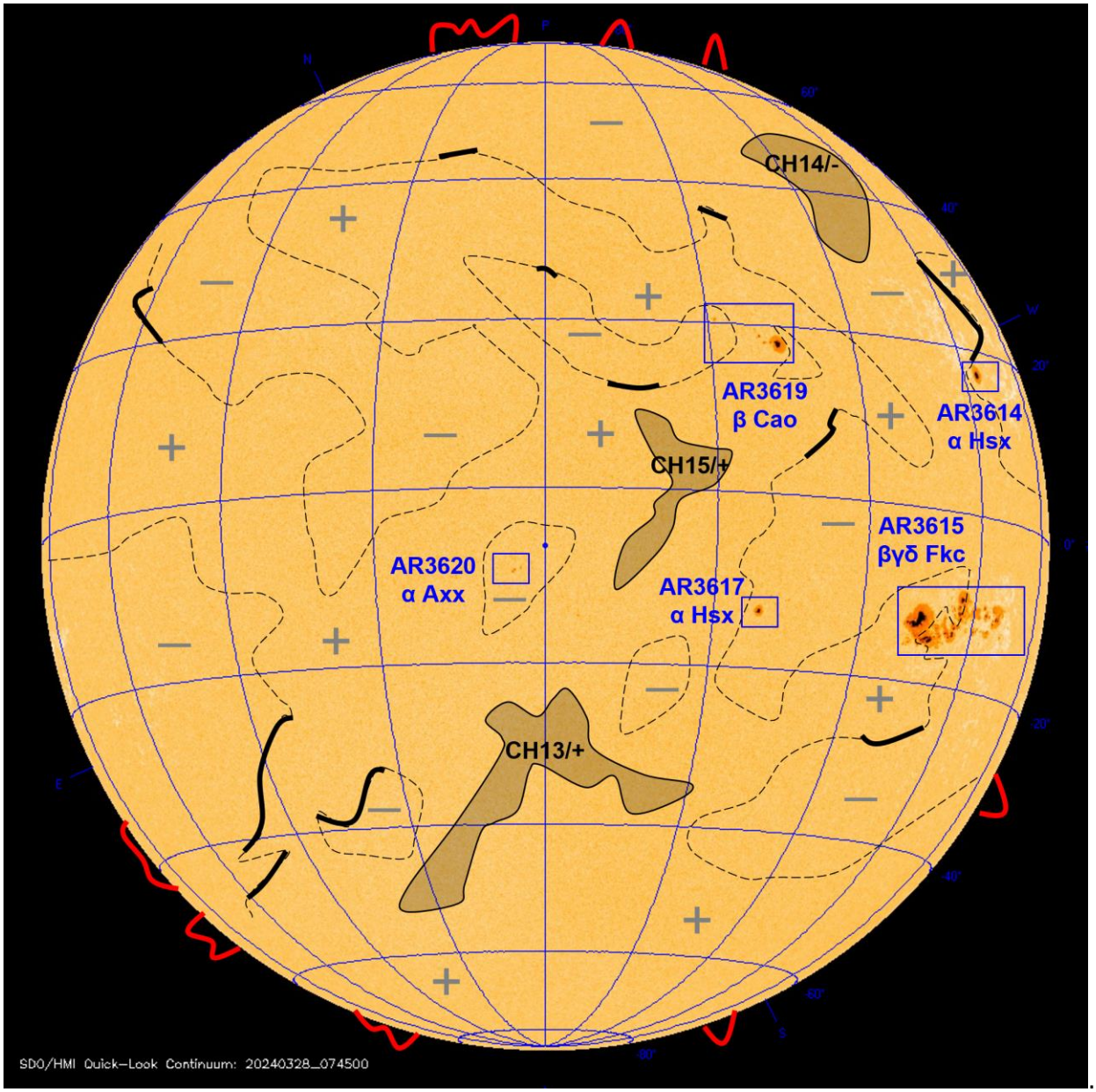
Energetic Particles / Solar Radiation: High energy proton flux, as observed by GOES18 is continuing to decline from recent enhancement. A continued slow decline towards background is expected in the absence of further significant flare activity.

High energy electron flux (greater than 2MeV) near background levels is expected to become enhanced, following the elevated solar winds, with a sharp increase to high levels probable by the end of the period. The associated 24-hour fluence probably breaching Active fluence levels through the guidance period.

Figure 1. Solar Analysis Valid 28/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME associated with the X1.1 flare from a broad region north of AR3614 on 23rd March, produced a notably complex halo CME which impacted L1 at 24/1410UTC. There are no other significant Earth-directed CME's currently anticipated.

Solar winds now at slightly elevated levels, with a continued slow decline towards background levels expected to continue as the impacts from the CME continue to wane, along with any residual enhancement associated with CH12/-. Connection with a HSS from CH15/+ is possible towards the end of the period, but little enhancement of solar wind or geomagnetic activity is expected in association with this feature given positive polarity and history from the last rotation.

Generally Quiet to Unsettled geomagnetic activity is expected through the guidance period in the absence of any further CME enhancements.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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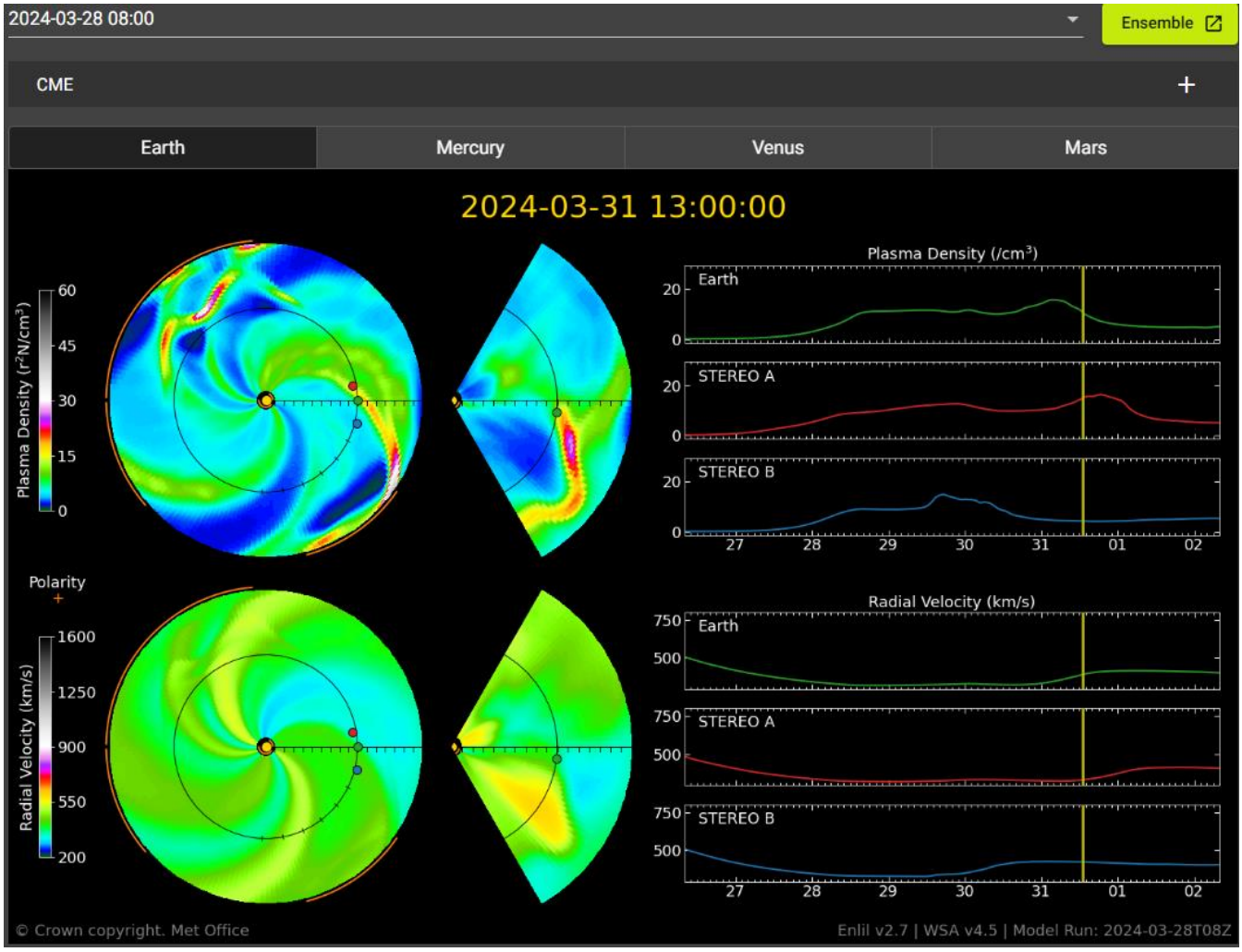
Figure 2: MOSWOC ENLIL, showing declining solar wind speeds, then a possible small enhancement Day 4 (31 Mar).



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Radio Blackouts - X-Ray Flares:

The current Earth-facing disc continues to be dominated by AR3615 (Fkc/Beta-Gamma-Delta). This region has been the most active region in recent days and has a history of M-class flares, including the recent M7.0. The X1.1 flare on the 23rd was primarily associated with AR3614, which remains generally stable and much more magnetically simple, though it remains within a large plage region. All other regions remain comparatively magnetically simple and much smaller.

AR3615 will leave the visible disc on Day 3 (30 Mar), but until then will continue to represent a high risk of activity, with further M-class flares expected and a chance of an isolated X-class flare. The risk of radio blackouts then declines, but some data from far-side sounding suggests that returning regions may rotate onto the southeast disk during the latter half of this guidance period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	40
Very Active	R3 to R5 X Class	No	20	20	20	10

Figure 3: GOES16/GOES18 X-Ray Flares

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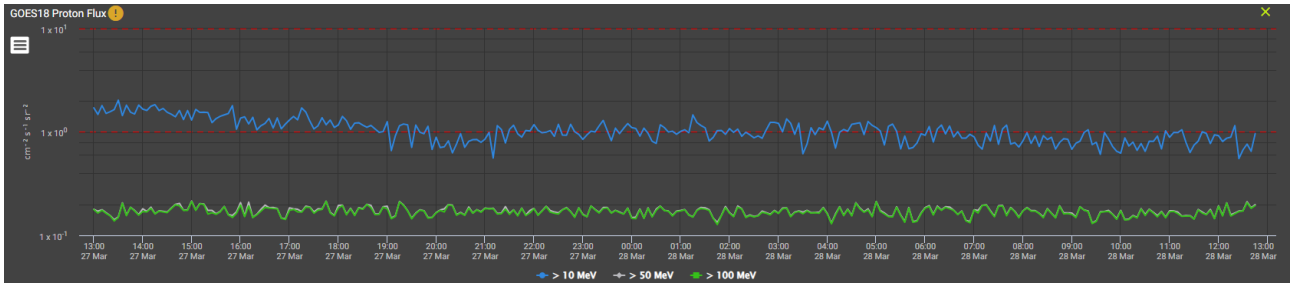
Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES18 is continuing to decline from the enhancement following the X-class flare last the weekend. A continued slow decline is expected in the absence of further significant flare activity, with the chance of any further enhancement dominated by AR3615. The risk of proton storms associated with larger flares will continue until the end of the period, even as AR3615 passes over the limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 Proton Flux, showing a gradual decline



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High Energy Electrons Event (≥ 2MeV):

GOES16 high energy electron flux is at background levels given the likely ongoing connection to the HSS of CH12/- and recent strong CME passage. As geomagnetic activity continues to be muted and solar winds are likely to ease over the next few days the electron flux at GEO is expected to quickly rise to moderate or high levels.

The associated 24-hour fluence is currently below the Active threshold. Fluence will rise sharply in the coming days with active fluence becoming increasingly likely. MOSWOC REFM output now shows better guidance than recently but may now actually be underplaying the anticipated increase in fluence in coming days.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	60	80	80	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	5	20	20	20

Figure 5: GOES16 Electron Flux (top) and MOSWOC REFM (bottom). REFM thought possible to be underplaying anticipated increase in fluence.

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